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Report to Congressional Requesters

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September 1990

NAVY SHIPS

Concurrency Within the SSN-21 Program



National Security and
International Affairs Division

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September 28, 1990

The Honorable Sam Nunn
Chairman, Committee on Armed Services
United States SenateThe Honorable Edward M. Kennedy
Chairman, Subcommittee on Projection
Forces and Regional Defense
Committee on Armed Services
United States SenateDTIC
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In response to your July 30, 1990, request, this report provides information on the extent to which development and production are concurrent in the Seawolf nuclear attack submarine (SSN-21) program, the status of the AN/BSY-2 combat system and other SSN-21 subsystems, and our opinion on whether procurement of the SSN-21 should be approved in fiscal year 1991.

FY-91
(Over)

Background

The SSN-21 is intended to counter the Soviet Union's new generation of quieter, more capable submarines. Designed to be quieter, deeper diving, and tactically faster, the SSN-21 is to provide enhanced capabilities and carry more weapons than the Los Angeles nuclear attack submarines (SSN-688s) being built today. In addition, the new AN/BSY-2 combat system is expected to provide the SSN-21 with greater capability to detect, classify, localize, and launch weapons against enemy targets.

In 1987, the Navy awarded the Newport News Shipbuilding and Dry Dock Company and the Electric Boat Division of General Dynamics SSN-21 design contracts that will run until June 1995, although most of the design work is scheduled to be completed by November 1992. In January 1989, the Navy awarded Electric Boat a fixed-price, incentive-fee contract to build the first SSN-21. Construction began in October 1989, and delivery of the ship to the Navy is scheduled for May 1995.

Originally, the Navy planned to buy 29 SSN-21s between fiscal years 1989 and 2000: 2 each in fiscal years 1991 and 1992 and 10 ships every 3 years thereafter. In August 1990, as a result of a Department of Defense (DOD) major warship and threat review, DOD's planned SSN-21 procurement was reduced to 3 submarines every 2 years, for a total of 14 submarines procured between fiscal years 1989 and 2000. Consequently, DOD decreased its original 1991 defense budget request from two to one

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SSN-21. Although reducing the number of SSN-21s to be constructed is expected to increase the cost of future ships, the Navy has not estimated the potential cost increase. The Navy, in its fiscal year 1991 budget request, originally asked for \$3.0 billion for the second and third SSN-21s.

Results in Brief

The SSN-21 is being designed and constructed concurrently. The first SSN-21 is under construction, and the Navy plans to award ship construction contracts for follow-on SSN-21s in November 1990. Under the Navy's current plans, seven SSN-21 submarines could be under construction or contract before the first ship is delivered in May 1995.

(cont. p. 1) → In addition to the overall concurrency of the SSN-21 design and construction program, we reviewed 10 of its subsystems and found that 6 subsystems involve concurrency. Four of these subsystems, including the AN/BSY-2, are critical to the ship's achieving full performance. A 1- or 2-year delay in contracting for the follow-on SSN-21, currently scheduled for November 1990, would allow for a longer period to develop the ship's and subsystems' designs. Under current Navy plans, some of the SSN-21's subsystems will not be operationally tested before initial production. Problems encountered during testing may identify weaknesses that require potentially expensive ship and/or subsystem modifications and possible schedule delays.

Current data do not adequately quantify the benefits and consequences of not providing funds to contract for another SSN-21 in fiscal year 1991. Potential benefits include a ship design that is more complete, an additional year to construct the first ship and develop the subsystems before contracts for subsequent ships are awarded, and an increased awareness of how rapidly changing world events will affect the Navy's requirements. According to Navy and SSN-21 shipbuilding officials, potential adverse consequences include higher unit costs and adverse effects on the industrial base. We believe the changing world events, the need to respond to the U.S. budget deficit, and the benefits of a less concurrent program warrant a 1-year delay in the award of the next SSN-21 production contract.

GAO concludes that
 Shipbuilding scheduling; Attack submarines;
 Contract administration. (EDC)

Design and Construction Status of First SSN-21

Overall, the concurrent design and construction of the first SSN-21 is about on schedule. As of August 1990, Newport News Shipbuilding and Electric Boat had collectively completed approximately 41 percent of the design work.¹ Newport News Shipbuilding and Electric Boat officials estimated that at least 81 percent of design work and the ship mock-up will be completed by November 1991. Ninety-seven percent of design drawings and the ship mock-up are scheduled to be completed by November 1992.

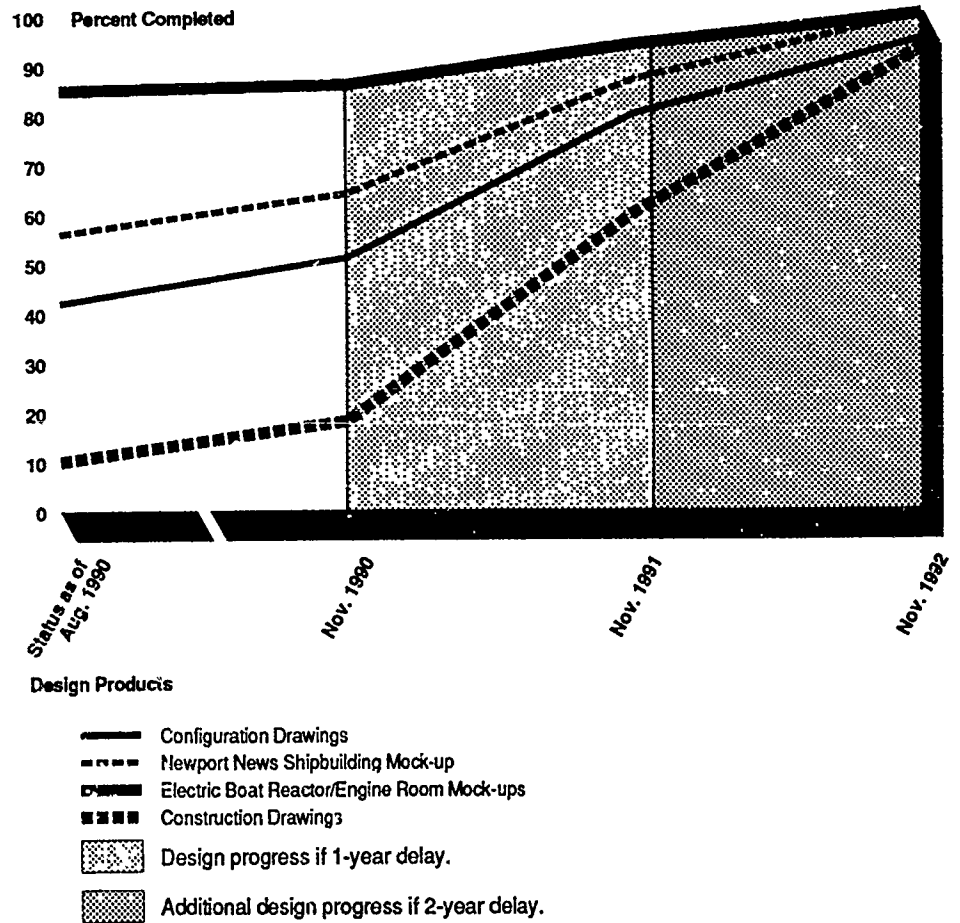
Figure 1 illustrates the progress estimated for design work completion during the next 2 years.



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¹Design work was calculated as the percentage of total required ship configuration drawings, ship mock-up drawings, and ship sectional construction drawings completed as of August 1990.

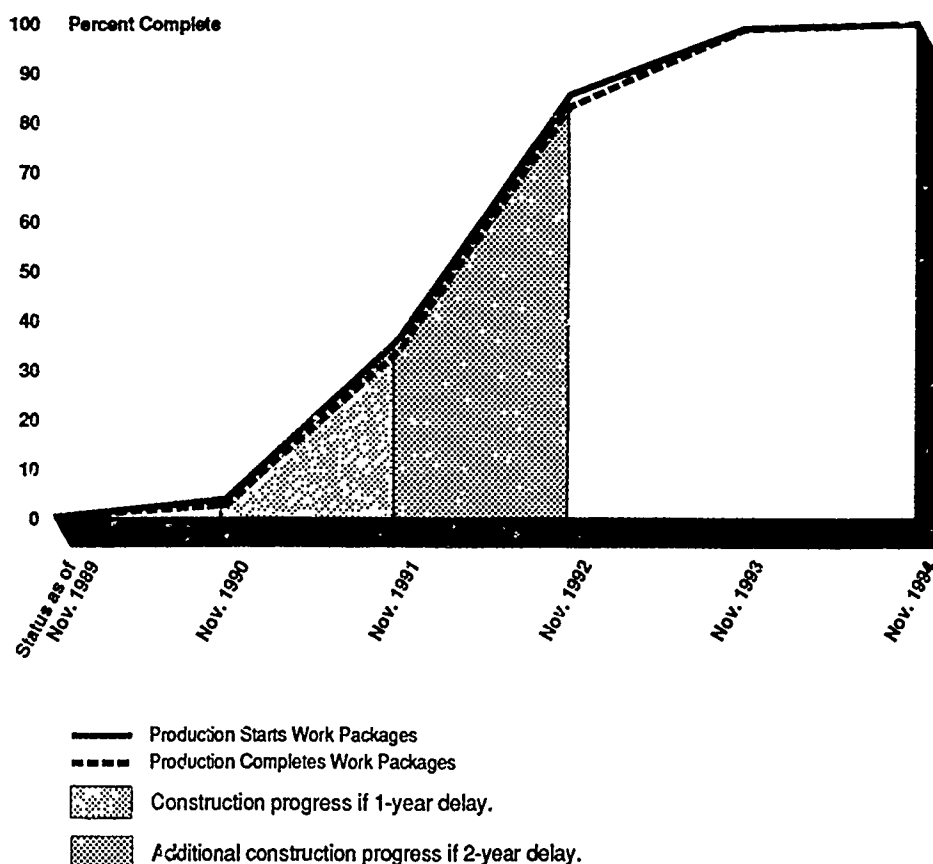
Figure 1: Current and Projected SSN-21 Design Status



Source: Newport News Shipbuilding and Electric Boat

As of July 1990, Electric Boat estimated that 3.1 percent of the labor, including support work and material procurement, had been completed for the first SSN-21. Electric Boat estimated that about 32 percent will be completed by November 1991 and about 55 percent by November 1992. According to Electric Boat and Navy officials, a delay of either 1 or 2 years in follow-on ship awards could have a negative effect on SSN-21 subcontractors and affect this projection. Figure 2 shows the estimated construction to be completed during the next 2 years. The curves reflect the number of work packages associated with sectional construction drawings.

Figure 2: Current and Projected SSN-21 Construction Status



Source: Electric Boat

Current Development and Production of Selected SSN-21 Subsystems

To meet the first ship's planned delivery date of May 1995, some subsystems require concurrent development and production. We reviewed 10 selected subsystems, of which 6 involve the use of concurrency.² These six subsystems are the AN/BSY-2 combat system, the noise monitoring system, the propulsor system, the ship control system, the weapons stowage and handling system, and the non-penetrating periscope. The most ambitious of these major system development efforts is the AN/BSY-2 combat system development program.

²The four selected subsystems that do not involve concurrency are the weapons launch system, the environmental system, the electronic support system, and the internal atmosphere control system.

Concurrency of AN/BSY-2 Subsystem and Components

In addition to the AN/BSY-2 system being developed and produced concurrently with the lead SSN-21 submarine, there is also concurrent development and production of several new key components within the combat system itself. These new components include a new enhanced modular signal processor (EMSP), towed array, and a wide aperture array, which represents significant advances in target detection and processing capabilities. These components are needed collectively to gather data on potential targets and to process and refine the data for use in making combat decisions. All of these components are being developed concurrently with the combat system software.

Moreover, much of the AN/BSY-2 hardware, such as work station processors and computer displays, will be newly developed and dispersed among several different vendors. Delays in development of hardware or software components could affect the schedule for the entire combat system. All AN/BSY-2 components, including those presently under development, must be integrated and tested by November 1994 in order to meet the delivery schedule for the first Seawolf submarine in 1995.

The first AN/BSY-2 system, which is planned for delivery to the Navy in November 1993, will consist of all hardware and about 86 percent of the software. At this time, it will lack about one-third of the sonar acoustics software. It will also not have undergone total system design certification testing. The remaining 14 percent of the system software is scheduled for delivery in November 1994. Installation of this software is scheduled to begin in January 1995, 4 months before the first SSN-21 is scheduled for delivery in May 1995.

If the AN/BSY-2 development and production schedules continue as planned, two additional AN/BSY-2 systems will be in production before all of the system components, such as EMSP, towed array, and the wide aperture array, have been fully developed, integrated, and tested. Navy plans call for using these two additional AN/BSY-2 systems to complete development of remaining system parts and resolve deficiencies disclosed during testing.

Advances in AN/BSY-2 Development in 1 or 2 Years

A 1-year delay—to November 1991—in procuring the second SSN-21 could reduce the risks of potentially expensive modifications by allowing more time to develop, test, and integrate the first AN/BSY-2 combat system. Production of the first AN/BSY-2 operational system is planned to begin only 2 months later in January 1992.

By November 1992, or after a 2-year delay in approving procurement of additional SSN-21s, most of the components for the first AN/BSY-2 will be in production, although development, testing, and integration are scheduled to continue through 1994. Final testing of the first AN/BSY-2 combat system is scheduled for January 1995, and final integration is not planned until the third combat system is in production.

Appendix I shows selected development and production milestones scheduled during fiscal years 1990-93 for major AN/BSY-2 components. It also shows milestones that could be completed during a 1-year delay in procuring the second SSN-21 (from November 1990 to November 1991) and during a 2-year delay (from November 1990 to November 1992). However, according to Navy officials, these development schedule advances are unlikely to be fully realized if the 1- or 2-year delay in procurement of the SSN-21 includes a delay in procurement of the second and third AN/BSY-2 combat systems because of their plans to use these systems to further develop and test the AN/BSY-2 software.

The Navy's concurrent approach is driving the need for three AN/BSY-2 systems to meet its planned delivery of the first SSN-21. Historically, major weapon acquisitions have not met their planned schedules. In the SSN-21 program, a slippage in the planned delivery of the first ship could result in the Navy's not having to procure the third AN/BSY-2 combat system during fiscal year 1991.

Concurrency of Other Selected Subsystems

Problems or delays during development and testing of the propulsor, noise monitoring, weapons stowage and handling, and ship control subsystems could delay ship construction and impair the ability of the first SSN-21 to perform its mission. A fifth concurrent subsystem, the non-penetrating periscope, was to be installed on the second and follow-on SSN-21s. However, according to Navy officials, the Defense Advanced Research Project Agency's design program has experienced problems that have delayed prototype testing. Until such testing is completed and the results are reported, the SSN-21 program office is not required to establish program guidelines for the non-penetrating periscope and its SSN-21 integration. SSN-21 program officials believe that work on integrating the non-penetrating periscope into the SSN-21 design will begin in fiscal year 1991.

Appendix II shows selected development and production milestones scheduled during fiscal years 1990-93 for these subsystems. It also shows milestones for these subsystems that could be completed during a

1-year delay in procuring the second SSN-21 (from November 1990 to November 1991) and during a 2-year delay (from November 1990 to November 1992).

Advances in Other Selected Subsystems in 1 or 2 Years

Four of these subsystems are in development and have not yet completed critical design reviews. By November 1991, however, development of the noise monitoring, ship control, and weapons stowage and handling systems will be close to completion. In addition, these subsystems will have undergone further testing and review. By November 1991, the noise monitoring system is scheduled to have completed critical design review, design verification tests, and qualification tests; the propulsor is scheduled to have completed initial operational testing; the ship control system is scheduled to have completed preliminary and critical design reviews; the weapons stowage and handling system is scheduled to have completed software specification, preliminary design, and critical design reviews and is scheduled to have started environmental testing; and the non-penetrating periscope is scheduled to have begun initial evaluations.

By November 1992, or after a 2-year procurement delay, the subsystems' development is scheduled to have completed additional milestones. The noise monitoring system is scheduled to have completed software integration testing and begun production of the first operational system, the ship control system is scheduled to have started software system integration and testing and begun hardware production, the weapons stowage and handling system is scheduled to have completed its test readiness review, and the non-penetrating periscope is scheduled to have completed evaluations and started full-scale development.

According to the SSN-21 program manager, significant problems or delays during the remaining testing of the propulsor subsystem could result in costly ship construction delays and could impair the first SSN-21's ability to perform its mission. However, the official believed that significant problems were unlikely because of the extensive testing already completed. He further stated that the ship construction program or the ability of the SSN-21 to perform its mission would not be significantly affected by problems or delays during the development and testing of the noise monitoring, weapons stowage and handling, and ship control subsystems. The scope of these subsystems is considered relatively small when compared to the total ship. To date, the project office has reported no significant problems or delays for these subsystems.

Navy's Assessment of the Impact of Delaying Procurement of the SSN-21

According to SSN-21 program officials, a 1-year delay in the SSN-21 program would result in a cost increase due to such things as inflation and decreased economies of scale. These officials provided us with an estimate. However, because they said the estimate was judgmental and they did not provide support for the estimate, we decided not to include it in this report. The Navy and the DOD Comptroller are having ongoing discussions on what the potential cost increase might be—the DOD Comptroller believes its estimate is lower than the Navy's estimate.

SSN-21 program officials also stated that a 2-year delay would cause a crippling blow to many key vendors who are highly dependent on SSN-21 work for their economic survival and would bring into question the viability of nuclear submarine construction. Appendix III provides a more detailed narrative on these views. The effects on the industrial base, while a valid concern, cannot be quickly analyzed. Furthermore, as a result of the changing world environment, the industrial base would likely have been affected anyway. We believe that Defense managers must begin to manage this issue. At the request of the Chairman, Subcommittee on Projection Forces and Regional Defense, Senate Committee on Armed Services, and the Chairman, House Committee on Government Operations, we have begun a review of this issue.

Finally, Navy, Electric Boat, and Newport News Shipbuilding officials say that a 1- or 2-year delay would require overhead costs to be apportioned over fewer projects and that, as a result, the lead SSN-21, the SSN-688, the Trident, and the aircraft carrier construction contracts would experience cost increases. Again, no specifics were provided.

The Changing Threat

The Navy views the Soviet Union's modern submarine force as the primary threat to the United States and its European interests and as the justification for the SSN-21 program. The Soviet Union continues to modernize its force with smaller but more capable submarines. Accordingly, in case of a crisis involving the Soviet Union, the Navy will need to counter this threat.

Recent social, economic, and military events (i.e., arms and troop reductions and the Soviet Union's alliance with the world community against hostile Iraqi actions), however, are changing the world's perception of the Soviet bloc. Many analysts believe that a global war with the Soviets is more unlikely today than at any other period in recent history. The reduced East-West tensions in conjunction with constrained defense budgets are also affecting U.S. military forces. For example, decreased

Soviet submarine patrols have prompted DOD to propose cuts in some U.S. antisubmarine warfare operations.

As the threat of global war with the Soviet bloc wanes, the Navy points to an emerging Third World diesel/electric submarine threat. However, in a May 7, 1990, Congressional Research Service Issue Brief entitled "Seawolf or SSN-21 Nuclear-Powered Attack Submarine," the following points were made:

"Opponents of the SSN-21 acknowledge that other potentially hostile countries, including China and a score of Third World countries, operate a collective total of about 250 attack submarines. But only 5 or 6 of these submarines (4 or 5 of China's and 1 of India's) are nuclear powered, and many of the others are older units of limited capability and dubious operational status. Moreover, they argue, it is unlikely that U.S. SSNs would ever be in hostilities with more than a small fraction of these submarines at any one time. The capabilities of the improved SSN-688s, they argue, will be more than sufficient to counter these potentially hostile non-Soviet submarines."

Agency Comments

Due to the short time available to conduct this review, we did not obtain written agency comments. However, we discussed the results of our work with DOD and Navy officials and have incorporated their comments where appropriate. According to the Navy, a 1- or 2-year delay in the SSN-21 program will increase the cost of current shipbuilding contracts, increase the cost of future SSN-21s, and further erode the shipbuilding industrial base. In addition, the Navy says that the SSN-21 program has a structured test program designed to begin subsystem testing early in development. The Navy believes that this process will preclude significant problems that would negatively affect design and construction of the first SSN-21.

It is also the Navy's position that the capability of the U.S. submarine force must be based on countering the capabilities of all our potential adversaries. For example, Soviet Union construction of significantly advanced classes of submarines is continuing. Although the majority of the Third World diesel submarines are less capable than modern U.S. nuclear submarines, the Navy's position is that they can be used effectively for several mission areas. The Navy also pointed out that in the last decade alone several countries have begun their own indigenous submarine programs and have made significant advances in quieting and air-independent propulsion technologies.

We are sending copies of this report to the Chairmen, House Committee on Armed Services, Senate Committee on Governmental Affairs, House Committee on Government Operations, and Senate and House Committees on Appropriations; the Director, Office of Management and Budget; and the Secretaries of Defense and the Navy. We will also make copies available to others upon request.

Appendix IV describes our objectives, scope, and methodology. Major contributors to this report are listed in appendix V. If you or your staff have any questions on this report, please call me on (202) 275-6504.

A handwritten signature in black ink, appearing to read "Martin M. Ferber", followed by a horizontal line.

Martin M Ferber
Director, Navy Issues

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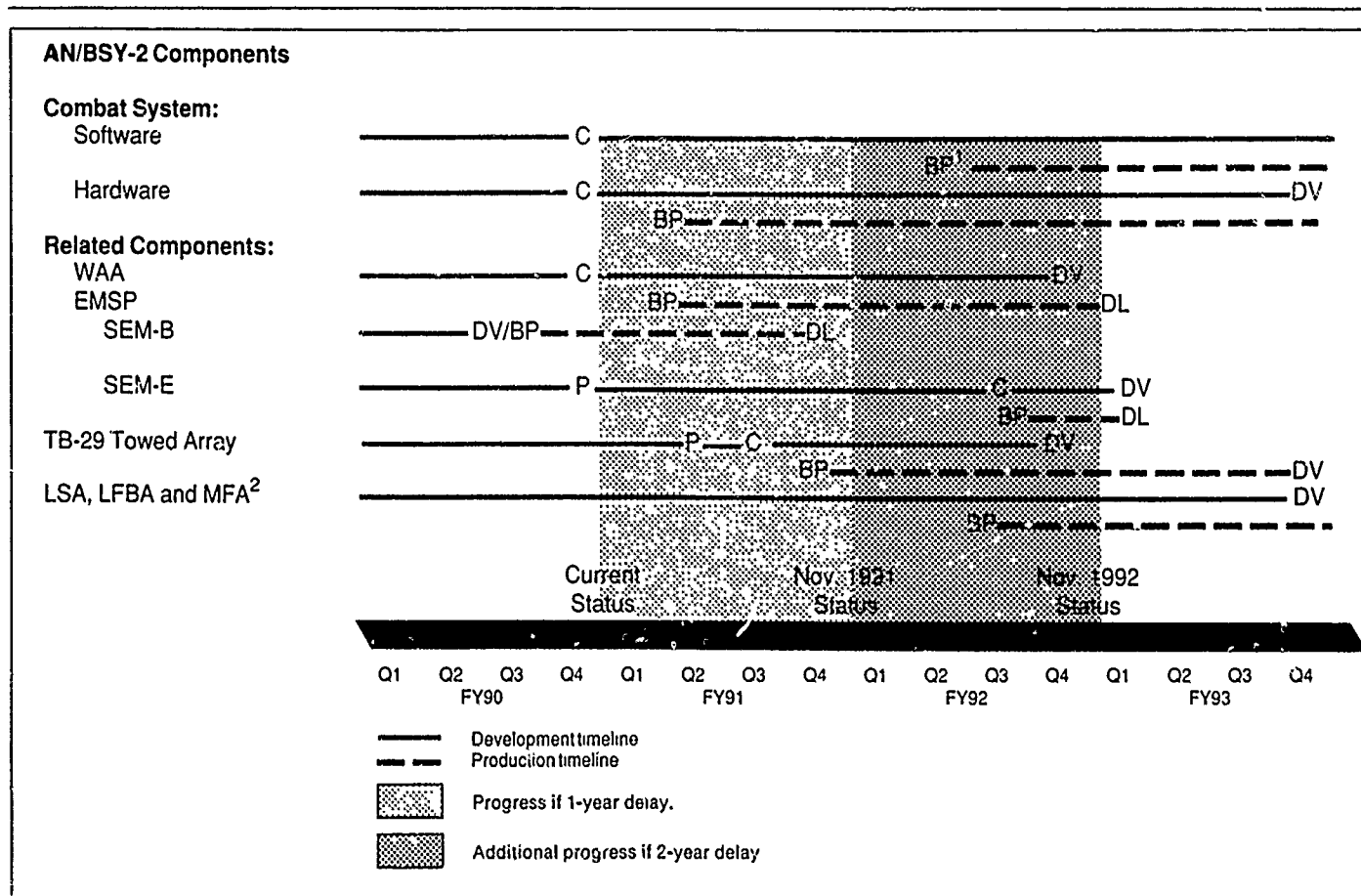
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Abbreviations

AN/BSY-2	SSN-21 combat system
DOD	Department of Defense
EMSP	enhanced modular signal processor
SSN-21	Seawolf nuclear attack submarine
WAA	wide aperture array
SSN-688	Los Angeles nuclear attack submarine

AN/BSY-2 Components: Selected Development and Production Milestones Fiscal Years 1990-1993



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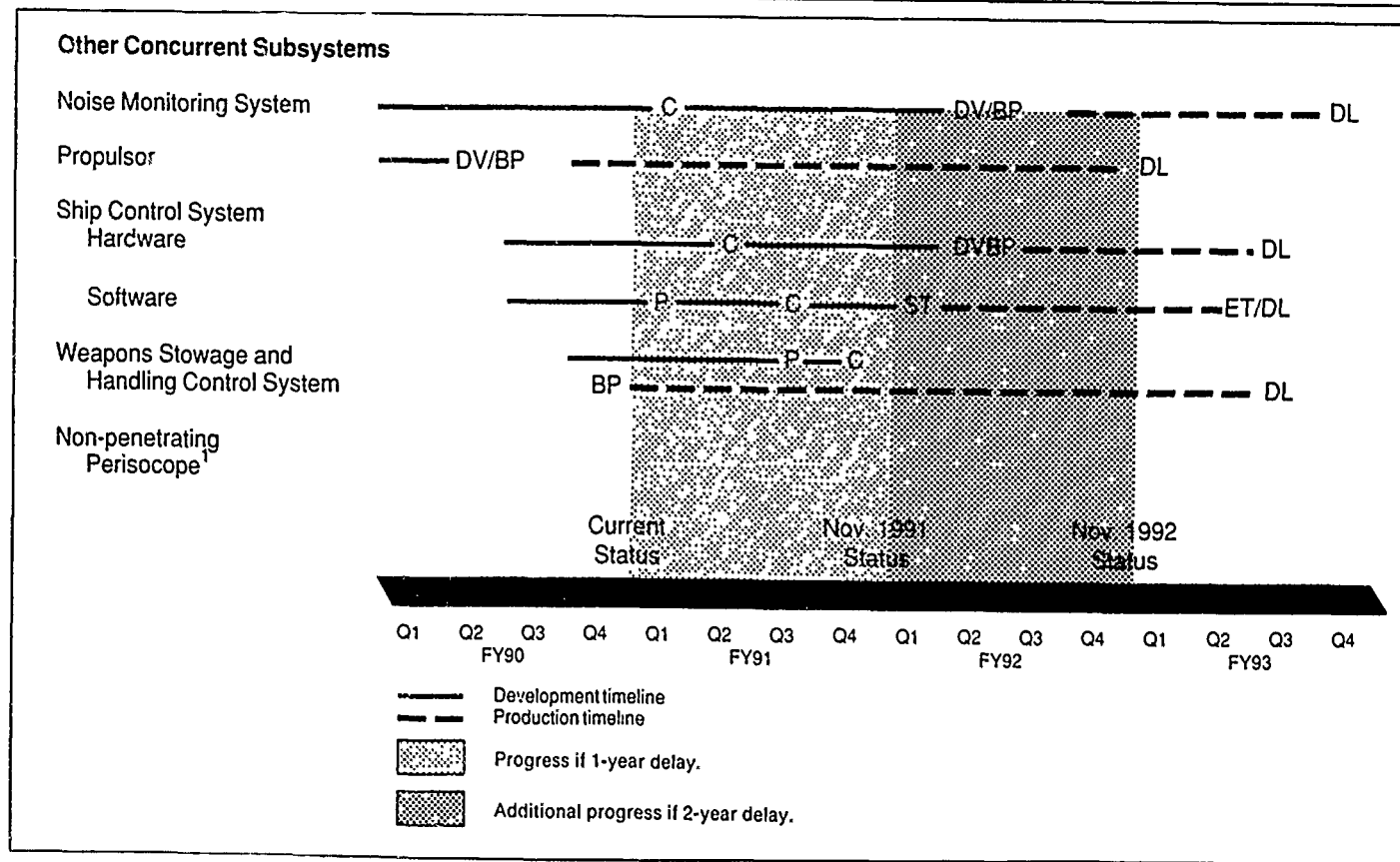
EMSP = Enhanced Modular Signal Processor
 LFBA = Low Frequency Bow Array
 LSA = Large Spherical Array
 MFA = Medium Frequency Active Array
 SEM-B = EMSP version for first three submarines
 SEM-E = EMSP version for remaining submarines
 WAA = Wide Aperture Array passive acoustics sensors

P = Completion of Preliminary Design Review
 C = Completion of Critical Design Review
 DV = Completion of component development
 BP = Begin production of first operation system
 DL = First delivery

¹Software production consists of downloading or copying the software to the new production hardware.

²According to the Navy SSN-21 program office, the SSN-21 program is responsible for hydrophones only.

Other Concurrent Subsystems: Selected Development and Production Milestones Fiscal Years 1990-1993



Legend:

- F = Beginning of full scale development
- P = Completion of Preliminary Design Review
- C = Completion of Critical Design Review
- ST = Start system integration and testing
- DV = Completion of component development
- ET = End system integration and testing
- BP = Begin production of first operational system
- DL = First delivery

¹Schedule not required as of September 1990.

Navy's Assessment of the Impact of Delaying Procurement of the SSN-21

According to the Navy, delaying procurement of the SSN-21 would negatively affect the existing supplier base. The U.S. shipbuilding industry is currently dependent on Navy work due to a loss in commercial ship construction work in the last decade. Despite the expansion of Navy ship programs during the mid-1980s, over the past 10 years, the industry has lost more than 40,000 people from the shipbuilding and repair programs and more than 100,000 people from industries supporting such programs.

Impact of Delaying Program on Vendor Base

A Newport News Shipbuilding official stated that there has been a significant reduction in the number of vendors supplying key commodities—steel, pipe, and valves—on existing construction contracts. Electric Boat has had similar experiences with vendors that provide commodities such as forgings, copper tubes, and structural steel. These officials have concluded that delaying future SSN-21 procurement would cause additional suppliers to leave the marketplace, resulting in higher overall product cost, longer lead times for materials, and reduced flexibility for the Navy and the shipbuilder. As mentioned earlier, we are beginning a review of the industrial base issue. At this time, we cannot comment on the impacts cited by the Navy and shipbuilding officials.

According to the Navy, since 1980, the number of U.S. suppliers providing key ship system components declined from 100 to about 77, or more than 20 percent. The Navy projects a further reduction of 17 suppliers by the year 2000. The number of suppliers providing key combat system components, however, has increased from 39 to 55, or 41 percent, during the last decade, but by the year 2000, a decline to 40 vendors is expected.

According to the Navy, decreased shipbuilding will further reduce competition and dual sourcing, which they say increased the number of combat system vendors during the 1980s. In addition, lower acquisition rates or the procurement of different types of ships could also adversely affect many essential vendors that are dependent on a single-ship class.

Because of the loss of commercial construction, changes in the mix of Navy ships, and a decline in U.S. vendors/suppliers, some equipment, such as air circuit breakers and large diesel engines, is supplied by only one domestic vendor. In addition, some equipment, such as crankshafts and turbochargers, for large diesels is available only from foreign sources. Electric Boat officials further stated that the submarine material supplier base is highly specialized. Previous declines in submarine construction activity have reduced the number of committed suppliers

to the minimum levels. The remaining supplier base has undergone numerous consolidations, divestitures, and buyouts as these suppliers reexamine their viability in the face of further cutbacks. According to these officials the preservation of the remaining supplier base is critical to the support of the existing submarine fleet as well as to the Seawolf program.

Electric Boat officials stated that a delay in awarding future SSN-21s will not only have an immediate impact on the vendor base for future SSN-21s but also could have an immediate negative effect on the first ship, which is currently under construction. If the remaining supplier base realizes insufficient near-term or future work in its product line, it will not make the requisite capital investments and required tooling and therefore will not bid on the first ship. These officials said that this could negatively affect the cost and performance of the first ship.

Objectives, Scope, and Methodology

The Chairmen, Senate Committee on Armed Services and its Subcommittee on Projection Forces and Regional Defense, asked us to (1) determine the level of concurrency within the SSN-21 program, with particular attention to the AN/BSY-2 combat system, and (2) provide our opinion on whether the Congress should approve procurement of the SSN-21 in fiscal year 1991.

We interviewed officials and reviewed relevant documents at the following locations:

- SSN-21 Program Office and AN/BSY-2 Combat System Program Office, Naval Sea Systems Command, Washington, D.C.
- Electric Boat Division of General Dynamics, Groton, Connecticut
- Newport News Shipbuilding and Dry Dock Company, Newport News, Virginia
- Navy Supervisor of Shipbuilding, Conversion, and Repair at Groton, Connecticut, and Newport News, Virginia

Due to the time constraints of this assignment, this report is based on our prior work, recent interviews with shipyard and Navy officials, and our analysis of program planning documents. We did not validate data or Navy or shipyard officials' statements.

To determine the level of concurrency within the SSN-21 program, we examined the status of the ship design, first-ship construction, and selected subsystems, including their development milestones. To determine the status of ship design, we interviewed shipyard and Navy Supervisor of Shipbuilding officials to determine the extent to which the design was on schedule. We also obtained data from each shipyard on how many drawings had been completed to date and how many were scheduled to be completed during the next 2 years.

To determine the first ship's construction status, we interviewed Electric Boat and Supervisor of Shipbuilding officials and obtained data prepared by Electric Boat regarding construction completed and construction scheduled to be completed during the next 2 years.

To determine the status of selected SSN-21 subsystems, we interviewed Naval Sea Systems Command officials and reviewed SSN-21 program office documents. We selected the 10 subsystems listed in this report based on historical congressional interest, their criticality to mission

performance, and suggestions by the program office. The Naval Sea Systems Command provided data on the subsystems' status and their development milestones scheduled during the next 2 years. Newport News Shipbuilding officials provided us with information on the status of and the scheduled milestones for the subsystems they are designing.

To determine the impact of delaying procurement of the 2nd and 3rd SSN-21s by 1 or 2 years, we (1) identified planned design, construction, testing, and subsystem development events scheduled during the next 2 years and (2) obtained opinions of Electric Boat and Newport News Shipbuilding officials. Shipyard officials' opinions were made based on the assumption that, after a 1- or 2- year delay, the SSN-21 program would continue as originally planned, that is, 3 boats purchased every other year for a total of 29 boats.

We conducted this review in August and September 1990 in accordance with generally accepted government auditing standards.

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